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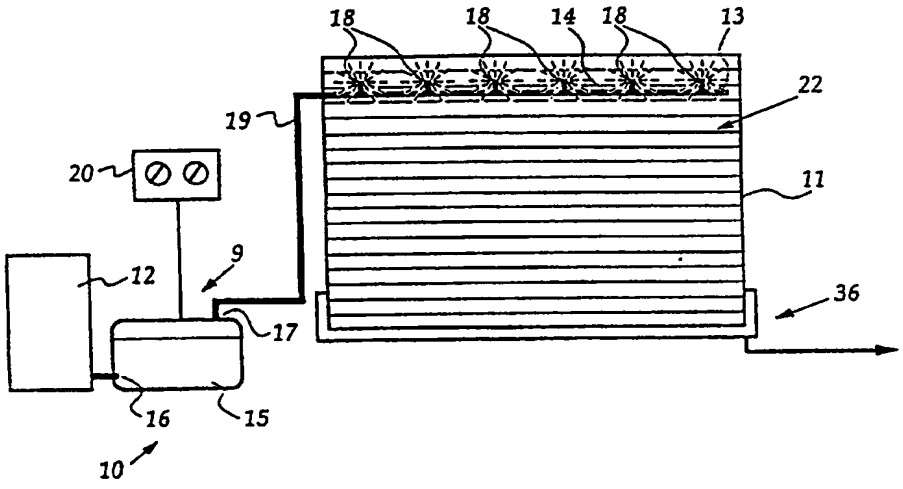
(54) Title: AUTOMATED DECONTAMINATION SYSTEM FOR AIR CONDITIONING PLANT



(57) Abstract

Treatment apparatus (10) is provided for maintaining a heat exchange surface, such as a cooling coil (11) in an air treatment plant, clean and efficient. The treatment apparatus (10) includes controlled pump means (14) for pumping liquid from a holding tank (12) to liquid distribution means (13) which periodically applies non-toxic treatment liquid to the heat exchange surface (11) while the air treatment plant is in operation. The treatment liquid is preferably a hydrogen peroxide based de-contaminant. The pump means (14) is controlled by timing means which periodically operates the pump means (14) for a set but selectively variable duration. The period of operation is suitably in the order of one month.

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--TITLE--

"AUTOMATED DECONTAMINATION SYSTEM FOR AIR CONDITIONING PLANT"

--BACKGROUND OF THE INVENTION--

This invention relates to decontamination systems for air conditioning plant and especially to automated decontamination systems.

This invention has particular relevance to decontamination methods and associated automated apparatus for inhibiting bacterial and fungal growth in air conditioning plant such as cooling coils and associated drains and for illustrative purposes particular reference will be made to such systems. However this invention may be utilised to achieve other benefits such as effective cleansing of air conditioning coils or economy of operation.

Modern air conditioning plants in vehicles and buildings deliver conditioned air to occupants to enhance their environment. Unfortunately, in many instances unless the air conditioning plants are adequately and regularly maintained they may also be effective in spreading disease to the occupants. This may result from a proliferation of bacteria and fungi within the air handling system. Furthermore, cooling coils which are not clean do not operate efficiently. Air conditioning plants are also used to condition food, such as for drying, heating or cooling and of course contamination in a conditioned air flow will contaminate the food.

Air supplied to building occupants by air conditioning systems generally passes through filters, which may be removed for replacement or servicing, and permanent cooling coils through which the filtered air passes for cooling and dehumidification for passage to the air supply ducts. The filters may be removed for servicing remote from the plant but the cooling coils require on-site servicing. Typically cooling coils are serviced by hosing with a high pressure water spray cleaner to wash the contaminates from the coil for discharge through permanent cooling coil drains. Such methods can force contaminates into the space between coil

fins and create further long term operating inefficiencies.

The coil may be treated initially with a proprietary cleaner to emulsify the contaminates to form a residue which the serviceman attempts to remove by hosing. Similar problems occur in heating coils, condensers, evaporators, cooling towers etc. Approved cleaning agents, generally in the form of spray-on liquids are applied to active components of air conditioning plant during servicing. However use of such approved agents does not ensure proper removal of all residue from the coils nor does it ensure that there will not be circulation of such cleaning agents with the conditioned air flow. As the cleaning agents may be toxic, such circulation is a potential health hazard. Accordingly while such servicing is in progress it is necessary to shut down the plant to the extent necessary to prevent the air supply circulating through the components being serviced. Prolonged shutdowns may cause inconvenience to the occupants or necessitate the service being performed outside normal working hours.

Manual servicing may be performed on an irregular basis or in an incomplete manner. This may be due to operator error or the difficulty of accessing the components for complete cleaning. Furthermore as the treatment liquid is normally applied to the cooling coils by manually operated sprays, excess treatment liquid is frequently applied. This contributes to costs and pollution. In addition a serviceman may not be able to confine the application of treatment liquid to the cooling coil. Thus excess treatment liquid may pollute the local area and may provide hazardous working conditions for the serviceman.

Air conditioning plant is also used in vehicles and ships, submarines, trains and planes and similar problems arise in each situation. However in the problem may be exacerbated in such applications due to the confined nature of the air conditioned zone.

--SUMMARY OF THE INVENTION--

The present invention aims to alleviate one or more of the above disadvantages and to provide a decontamination

method and maintenance apparatus for air conditioning plant which will be reliable and efficient in use.

With the foregoing in view, this invention in one aspect resides broadly in a method of treating an active heat exchange surface, the method including:-

providing liquid distribution means for distributing liquid to the active heat exchange surface, and

periodically supplying a treatment liquid to the liquid distribution means for distribution to the active heat exchange surface. Preferably the treatment liquid is a suitable non-toxic cleaning liquid or de-contaminant which contains surfactants and/or foaming agents and preferably the cleaning liquid is a hydrogen peroxide based de-contaminant which may be modified by the addition of one or more of silver nitrate or other soluble silver salt, surfactants, stabilisers, or the like. Suitably only sufficient treatment liquid is applied to complete the decontamination and/or cleaning of the apparatus.

It is also preferred that a preselected quantity of treatment liquid be applied over a short period during operation of the air conditioning system at a preselected interval and suitably not less than once every 32 days and preferably not less than once every 28 days so as to prevent microbial growth to the extent that the quality of the conditioned air is compromised.

Suitably metering means may be provided to ensure that a metered amount of treatment liquid is supplied to the liquid distribution means. The metering means may be in the form of a header tank associated with the liquid distribution means and adapted to contain or at least discharge the desired amount of treatment liquid into the system. Preferably however the metering means includes a pump adapted to pump treatment liquid from a remote reservoir to the liquid distribution means. The pump may be associated with timing means which may control the period of operation of the pump and thus the volume of liquid supplied, and/or the frequency of operation of the pump. Suitably the frequency is adjustable and may be arranged to coincide with conventional

or selected service periods or weekly, quarterly or as desired and the period of pumping is adjustable to cause the desired volume of liquid to be pumped and such as, for example, to deliver from about five to twenty litres of treatment liquid to the cooling coil of a building air conditioning plant.

In a one embodiment of the invention the pump is adapted to operate at a substantially constant pressure and the liquid distribution means includes a header tube of the type which may be apertured or punctured to enable spray nozzles to be secured operatively thereto. Alternatively the header tube may have evenly spaced spray nozzles therealong whereby it may be cut to length on-site to suit the width of the coil, the nozzle characteristics and spacing being such that a length corresponding to a coil width will enable an appropriate volume of treatment liquid to be applied over at least the upper portion of a coil. Preferably the tube is formed from a flexible thermoplastic material such as polybutylene, which does not support microbial growth and which has the ability to expand many times its size to accommodate freezing of treatment liquid in the tube without rupturing.

In a further aspect the method may include supplying a appropriate header tube with spray outlets and adjustable timing means for adjusting the frequency and/or duration of spraying to ensure that the correct quantity of treatment liquid is applied to the coil.

The active heat exchange surface may be a cooling coil and the liquid distribution means may be arranged to distribute liquid substantially across the full width of the cooling coil. The arrangement may be such that condensate formed on the cooling coil is utilised to wash the treatment liquid over the active heat exchange surface. Alternatively the cleaning liquid may be supplied in sufficient quantity and in a manner to perform the cleaning function without assistance of the condensate. For example, the liquid distribution means may include an oscillating distribution tube or tubes or fixed tubes which spray treatment liquid

substantially over the full face of the apparatus to be cleaned. The tubes may be horizontally or vertically disposed or inclined as desired. Alternatively an array of upper and lower spray tubes may be used to apply the treatment liquid. Horizontal spray tubes may be arranged with fan jets spraying inwards and downwards to extend the coverage down the face of the cooling coil or whatever apparatus is being treated.

The liquid distribution means is preferably provided as a fixed installation for each apparatus to be treated but if desired mobile liquid distribution means could be provided for supplying treatment liquid individually to a plurality of cooling coils in an air conditioning system.

The treatment liquid may comprise a cleaning and/or biologically active liquid composition. For example, the liquid composition may be selected from foaming or non-foaming surface active agent containing compositions, with or without the addition of antibacterial or other antimicrobial compounds or formulations. The treatment liquid is preferably formulated to minimize deleterious effects on the material of the cooling coils. For example, liquids for use on aluminium containing coils are preferably selected from those not containing strong acids or bases or at least those where such aggressive materials are suitably buffered. Liquids for use in conjunction with copper containing materials are preferably ammonia free.

In another aspect this invention resides broadly in treatment apparatus including:-

liquid distribution means for distributing liquid to heat exchange apparatus;

pump means for pumping liquid from a holding tank to the liquid distribution means, and

timing means for controlling the period of operation of the pump and/or the frequency of operation of the pump.

The liquid distribution means may include an array of spray heads and a supply manifold which may be arranged adjacent the upstream face of a cooling coil or other heat exchange apparatus to provide a spray which covers the inlet

complete face of the coil. Alternatively the liquid distribution means may include a series of spray or liquid outlets spaced along a tubular rail which may be supported in front of the upper portion of the cooling coil in such manner that treatment liquid is distributed directly to the upper portio of the coil. The treatment may feed gravitationally over the entire coil or be distributed thereover by eddy currents formed about the closely spaced heat exchange surfaces of the apparatus. Distribution may also be assisted by the flow of condensate which will carry some treatment liquid over the apparatus to operatively treat or clean the apparatus.

It is preferred that all piping associated with the pump and liquid distribution means be formed of flexible thermoplastic pipe and in particular polybutylene pipe to reduce the potential for microbial growth in the liquid distribution means and to simplify installation. Suitably the liquid distribution means constitutes one or more lengths of polybutylene pipe having self-threading screw-in spray nozzles at regular intervals therealong and adapted to be fixed in position extending across from one side of the cooling coil, or other apparatus, to the other so as to spray treatment liquid over the upper portion thereof.

In yet another aspect this invention resides broadly in treatment apparatus for air conditioned buildings provided with a plurality of fan-coil units each providing a conditioned air flow and to methods of operating same, wherein:-

each fan-coil unit is associated with a respective liquid distribution means for distributing liquid to coil;

each fan-coil unit or a set of fan-coil units is connected a treatment supply line through remotely controlled valve means;

pump means is provided for pumping treatment liquid from a holding tank to the treatment supply line, and

timing means is provided for controlling the period of operation of the pump and/or the frequency of operation of the pump and, during operation of the pump, for selectively

controlling the remote controlled valve means to sequentially supply treatment liquid to the fan-coil units. Preferably the liquid distribution means is of the type defined above.

In a further form the treatment apparatus as defined in the above aspects may include switching means for switching the source of liquid supplied to the liquid distribution means from treatment liquid to flushing liquid, preferably water, and the timing means for supplying flushing liquid at regular and frequent intervals such as daily or weekly, for flushing particulate or condensable air borne contaminants from the heat exchange surface. Typically in a coastal environment water flushing may be provided on a daily basis to prevent salt residue accumulating on the heat exchange surface which may be a cooling coil or a fan-coil, for example.

This invention also resides in air conditioning systems incorporating treatment apparatus as defined above.

--BRIEF DESCRIPTION OF THE DRAWINGS--

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate typical embodiments of the invention, wherein:-

Fig. 1 is a diagrammatic illustration of the installation of treatment apparatus on a cooling coil;

Fig. 2 illustrates a typical screw-in spray head;

Fig. 3 is diagrammatic cross-sectional view of the pump assembly, and

Fig. 4 is a typical circuit diagram for the automatic electronic control apparatus.

--DESCRIPTION OF THE PREFERRED EMBODIMENT--

The treatment apparatus 10 is adapted to spray liquid treatment from a reservoir 12 onto a cooling coil, illustrated diagrammatically at 11. The treatment apparatus 10 includes liquid distribution means 13 in the form of a polybutylene plastics header pipe 14 extending across the top of the cooling coil 11 and having screw-in plastic spray nozzles 18 fitted thereto at intervals of between 50mm to 150mm along the length of the pipe 14 which is supported

100mm - 150mm away from the cooling coil surface. The spray nozzles 18 are suitably of the type utilised for domestic garden irrigation systems and are each able to spray 22 litres of treatment liquid per hour at 150 kPa.

Treatment liquid is pumped from the reservoir 12 by a pump assembly 9 which includes an integral pump, electric drive motor and cooling fan enclosed in a plastic housing 15. The pump assembly 9 has an inlet 16 communicating with the reservoir 12, an outlet 17 communicating with the liquid distribution means 13 and air inlet and outlet ports. The pump has a capacity of 170 litres/hour at maximum head pressure of 160 KPA. The header pipe 14 and the supply pipes 19 are formed from the same pipe which is suitably 20mm diameter polybutylene pipe. Compression type joining fittings are used throughout the apparatus.

A remotely located electronic timer 23 is associated with the power supply for the pump assembly 9 whereby the frequency, suitably thirty day intervals, and the period, adjustable in five second increments from ten seconds upwards to a maximum of one minute. The timing parameters are determined by the size of the apparatus to be treated and fine tuned by experimentation as required.

The timer circuit is illustrated in Fig. 4 and includes a power supply 24 which produces a regulated twelve-volt supply for the timing circuit 25 and an unregulated twenty-four-volt or one hundred and ten volt circuit for the relay 26. The timing circuit 25 comprises a fast-cycle timer 27 and a slow-cycle timer 28, the timers 27 and 28 being coupled to a switching transistor 29 through flip-flop 30. The switching transistor 29 controls the operation of the relay 26, the latter energising or de-energising the pump 9 according to the output from the flip-flop 30. Each of the timers 27 and 28 consists of an R-C oscillator and a binary divider network, the latter enabling long time intervals to be controlled with relatively small timing capacitors. The slow timer 28 has its power supply backed up by a lithium battery 33, which allows it to maintain its timing function during mains power failures. The flip-flop 30 processes the

output from the timers 27 and 28 to yield a signal which the relay 26 to "off" for a period controlled by the slow-cycle timer 28, switches the relay 26 to "on" for a period controlled by the fast-cycle timer 27, and then repeats the cycle continuously. The duration of the "off" interval is controlled by the adjustable potentiometer 34 while the duration of the "on" period is controlled by the adjustable potentiometer 35.

The pump assembly 9, the timer 20, the reservoir 12, piping and compression fittings including the header pipe with spray nozzles 18 fitted at between 5mm to 250mm intervals are suitably supplied as an installation kit whereby the on-site installation is limited to trimming the header pipe 14 to length to suit the width of the cooling coil and mounting the cut length above the cooling coil 11, and connecting the components in conventional manner with the connectors supplied. Preferably the reservoir 12 is filled with a water based treatment liquid containing 1.5% to 5% hydrogen peroxide together with traces of silver nitrate and a surfactant, the concentration of silver nitrate being typically in the range of 0.0011% to 0.0035% w/v.

When installed, the timing circuit 23 will ensure that once every thirty days, or other selected interval, and while the air conditioning plant is operating, treatment liquid is pumped from the reservoir 12 to the header pipe 14 for distribution from the nozzles 18 to the top portion 22 of the coil 11. Pumping continues for a selected interval to ensure the appropriate amount of treatment liquid is supplied to suit the size of the coil. The treatment liquid will spread through the coil, being carried down over the coil by condensate, gravity or eddy currents to ensure adequate coverage of all exposed heat exchange surfaces. This treatment operation will be carried out automatically, irrespective of other servicing which may be performed and will significantly reduce the proliferation of fungi and/or bacteria on the cooling coil, the adjacent air flow plant and the drains 36 and will maintain the coil in an operative clean state so as to enhance the air conditioning

performance, including minimising running costs. Use of a hydrogen peroxide based treatment will assist in minimising growth of viruses, bacteria, fungi, protozoans and other micro-organisms which may cause illnesses. Furthermore the hydrogen peroxide based treatment can be admitted to the treated air stream without concern of adverse affects on most occupants. This treatment liquid is bio-degradable , non-residual and non-corrosive.

In a large building where many cooling coils require servicing, the timing apparatus 20 may constitute a master controller adapted to sequentially actuate a plurality of pumps and associated liquid distribution means. Alternatively a manifold and solenoid valves may be used to enable a single pump to sequentially supply the treatment liquid to respective liquid distribution means.

Apparatus for vehicles and the like is similar to the above described embodiment but is generally smaller. Furthermore, as it is likely that such installations will operate intermittently and not as regularly as plants in buildings, the timing apparatus 30 has an in-built time clock and rechargeable power source which will apply the treatment once every 25 to 30 days and when the engine is running if possible, suitable sensors and timing arrangements being provided for that purpose.

It will be understood that the above has been given by way of illustrative example of the present invention and that all such modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as is defined in the appended claims.

--CLAIMS--

1. A method of treating a heat exchange surface, the method including:-

providing liquid distribution means for distributing liquid to the heat exchange surface, and

periodically supplying a treatment liquid to the liquid distribution means for distribution to the heat exchange surface.

2. A method of treatment as claimed in claim 1 and wherein the heat exchange surface is part of an air conditioning plant, the method further including providing non-toxic liquid for supply to the liquid distribution means while the plant is in operation.

3. A method of treatment as claimed in claim 2, wherein the non-toxic liquid is a hydrogen peroxide based de-contaminant.

4. A method of treatment as claimed in any one of the preceding claims, including applying a preselected quantity of treatment liquid over a short period at preselected intervals.

5. A method of treatment as claimed in claim 4, wherein the preselected interval is not less than once a month.

6. A method of treatment as claimed in any one of the preceding claims, including providing metering means for supplying a preselected quantity of treatment liquid to the liquid distribution means.

7. A method of treatment as claimed in any one of the preceding claims, wherein said metering means includes a pump adapted to pump treatment liquid to the liquid distribution means at a substantially constant pressure and timing means for selecting the duration of operation of the pump.

8. A method of treatment as claimed in any one of the

preceding claims, wherein said liquid distribution means includes a header pipe having evenly spaced spray nozzles therealong and which may be cut to length on-site to suit the width of the coil, the nozzle characteristics and spacing being such that a length corresponding to a coil width will enable an appropriate volume of treatment liquid to be applied over at least the upper portion of a coil.

9. A method of treatment as claimed in claim 8, wherein the header pipe and associated piping is formed from a flexible thermoplastic material.

10 A method of treatment as claimed in claim 9, wherein the thermoplastic material is polybutylene.

11. Treatment apparatus including:-

liquid distribution means for distributing liquid to heat exchange apparatus;

pump means for pumping liquid from a holding tank to the liquid distribution means, and

timing means for controlling the period of operation of the pump and/or the frequency of operation of the pump.

12. Treatment apparatus as claimed in claim 1, wherein:-

said liquid distribution means is a selected length header pipe cut from a length of flexible thermoplastic pipe having spray nozzles at regular intervals therealong;

said pump means supplies liquid at a substantially constant pressure, and

said timing means is adjustable and controls the period and operating interval of said pump.

13. A cooling coil assembly, including:-

a cooling coil, and

liquid treatment apparatus as claimed in claim 12.

14. A cooling coil assembly as claimed in claim 13, and

wherein said header pipe is disposed adjacent but spaced from said cooling coil upstream from the inlet side thereof.

15. Treatment apparatus for air conditioned buildings provided with a plurality of fan-coil units each providing a conditioned air flow, wherein:-

each fan-coil unit is associated with a respective liquid distribution means for distributing liquid to coil;

each fan-coil unit or a set of fan-coil units is connected a treatment supply line through remotely controlled valve means;

pump means is provided for pumping treatment liquid from a holding tank to the treatment supply line, and

timing means is provided for controlling the period of operation of the pump means and/or the frequency of operation of the pump means and, during operation of the pump means, for selectively controlling the remotely controlled valve means to sequentially supply treatment liquid to the fan-coil units.

16. Air conditioning systems including a cooling coil or a plurality of fan-coil units and treatment apparatus as claimed in claim 12 or claim 15 associated therewith.

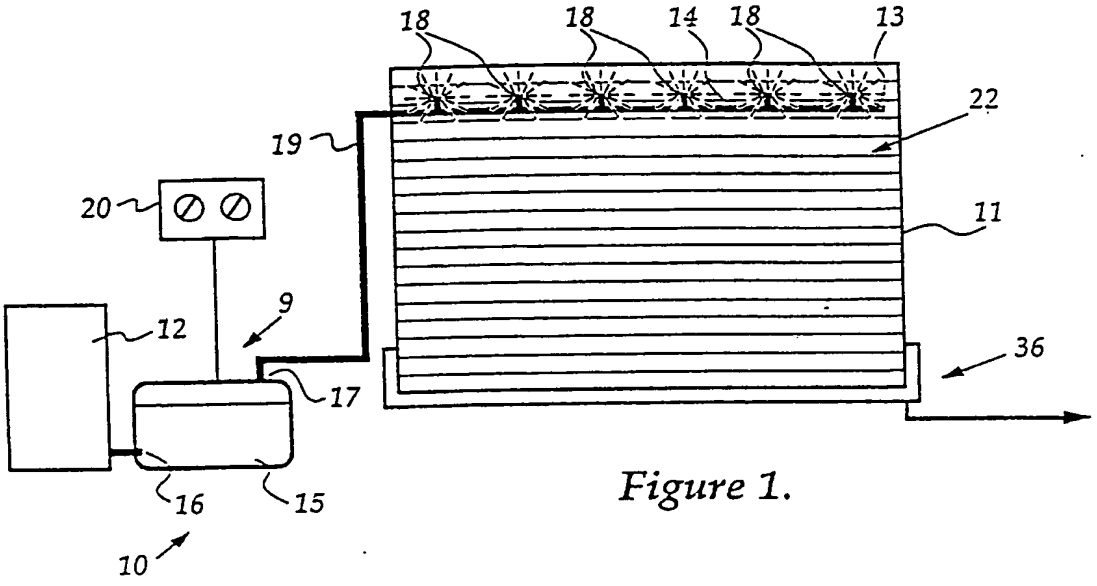


Figure 1.

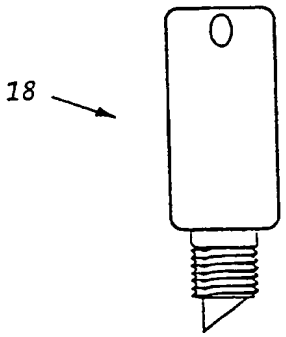


Figure 2.

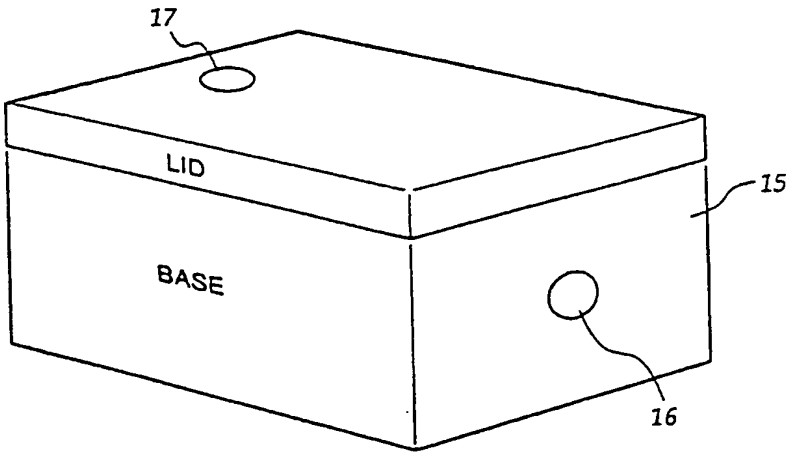
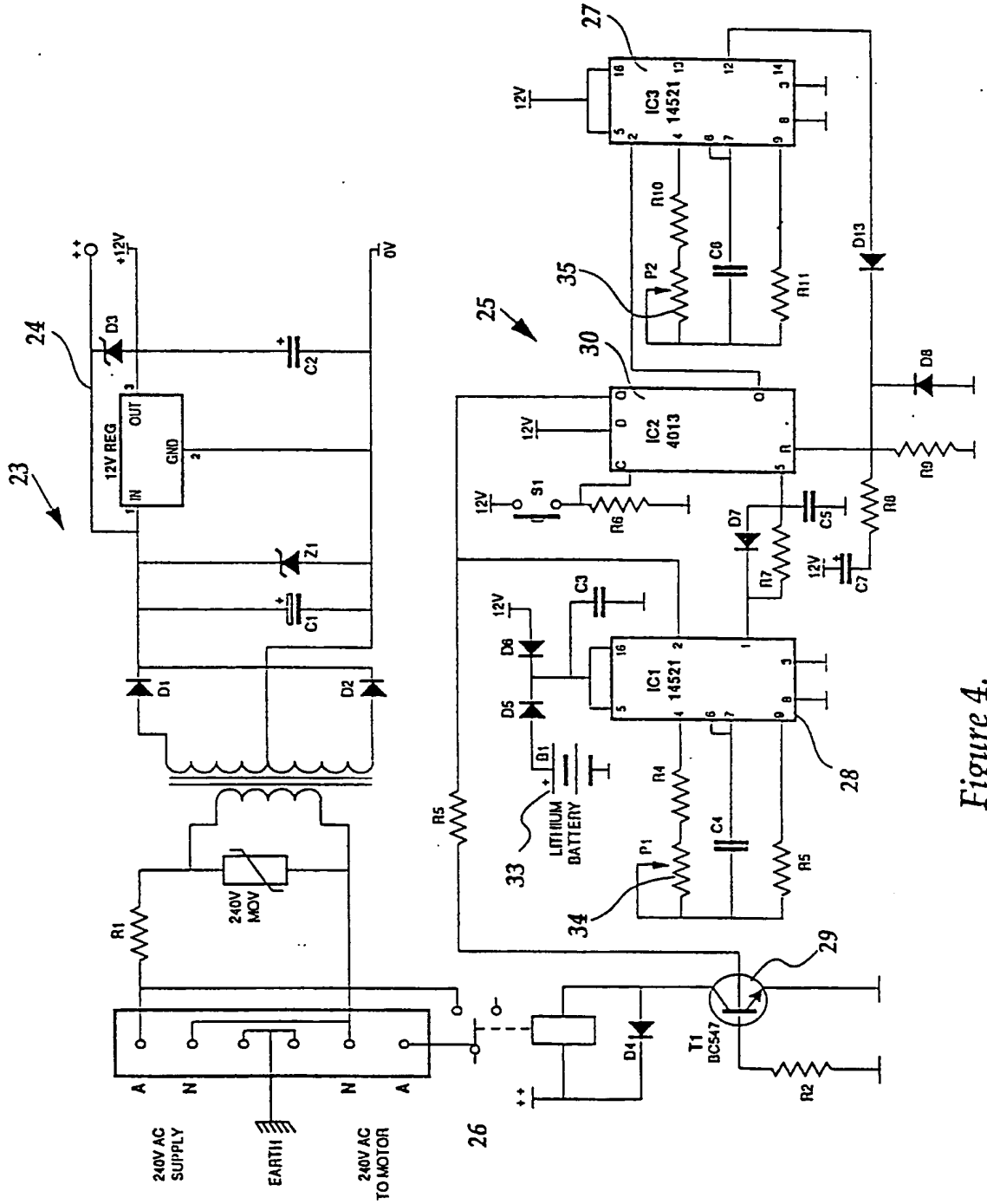


Figure 3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IN
OUT
GND
+12V
0V
240V MOV
240V AC SUPPLY
EARTH
240V AC TO MOTOR
LITHIUM BATTERY
IC1 14521
IC2 4013
IC3 14521
DC547

Figure 4.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 94/00032

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[5] F28G 9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC F28G 9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
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Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	GB,A, 2249827 (H & M DISINFECTION SYSTEMS LIMITED) 20 May 1992 (20.05.92) See figure 2.	1-16
X	US,A, 4315414 (IBRAHIM) 16 February 1982 (16.02.82) See figures 1 and 3.	1-16
X	EP,A, 364381 (SAFRAIR) 18 April 1990 (18.04.90) See figure 1, items 10,11,12.	1-16

(continued)

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 May 1994 (04.05.94)	11 May 1994 (11.05.94)

Name and mailing address of the ISA/AU	Authorized officer
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X	DE,A, 3336367 (VEB KOMBINAT TEXTIMA) 12 April 1984 (12.04.84) See figure 1, item 12.	1-16
A	DE,A, 4033321 (BAYERISCHE MOTOREN WERKE) 23 April 1992 (23.04.92)	
A	US,A, 4428417 (CHESNER) 31 January 1984 (31.01.84)	
A	DE,A, 3930493 (WEIGAL) 14 March 1991 (14.03.91)	

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
GB 2249827	
US 4315414	
EP 364381	FR 2637966 FR 2643444
DE 3336397	CH 661479 GB 2128570 JP 59073998 US 4524857
DE 4033321	
US 4428417	
DE 3930493	EP 493402 WO 9104452
	END OF ANNEX